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RECENT PROGRESS IN ENTOMOLOGY.

WITHIN recent years the development of the closely related subjects of insect physiology and ecology have shown some remarkable advances due to the demand for increased knowledge by the applied entomologist. Insect ecology serves to study the relation of the insect to its environment in its broadest conception, and in the physiological aspects of this relationship ecology grades into physiology. Great impetus has been received in the study of insect ecology from the realisation that a knowledge of the relation of insects to their physical environment, the interaction of different species and the underlying causes of both migration and fluctuations in insect populations, to mention a few problems only, is of importance in insect control.

Few ecological methods have been exploited as yet by the applied entomologist. The more important of these include first, cultural methods of control such as regulation of the growth of the crop, secondly, the production of varieties of plants resistant to insect attack and, thirdly, the control of insect pests by the use of their parasites and predators and of injurious weeds by their insect enemies. This latter method, which has come to be known as biological control, is perhaps the most interesting of ecological ideas to be applied so far, and some years ago was at the height of its popularity. Numerous introductions of insect parasites into new regions have been conspicuously unsuccessful, having been made in advance of a sound knowledge of the ecology of both host and parasites in their new environment. Such empirical procedure has brought the method into disfavour in some quarters.

Recent work on biological control has been done on the pea moth, which is a serious pest in Canada, and the diamond-back moth, which attacks cruciferous crops and is an important pest in New Zealand. The pea moth was accidentally introduced from Europe into Canada, where no parasites have apparently succeeded in attacking it and it has become extremely abundant, while in England the infestation is maintained at a comparatively low level and there is a fairly high rate of parasitism. On these grounds the pest is believed to be well suited to biological control.

A similar case for the application of biological control methods can be made out for the diamond-back moth. This ubiquitous species, on becoming

established in New Zealand, soon reached pest proportions. In most other countries parasites are largely responsible for its destruction and in England its absence as a serious pest is attributed mainly to the action of parasites. In New Zealand on the other hand, the pest has to contend with no natural enemies of any importance and consequently maintains its population at a permanently high level. As the climate of England and New Zealand are essentially similar it is supposed that the introduction of parasites from the former country will lead to the eventual control of the pest in New Zealand.

In the West Indies Dr. J. G. Myers was engaged for a number of years on biological control work which was largely exploratory in nature. His recommendations included the introduction of various parasites, and such of these as have already been introduced have not as yet been conspicuously successful. Exception may be made as regards the Amazon fly, introduced from Brazil into British Guiana for the control of the sugar-cane moth-borer, which has given some measure of success, and has since been introduced into St. Lucia, Trinidad and Puerto Rico from material bred in British Guiana and into Antigua from St. Lucia.

It has now come to be generally realised, as Dr. A. D. Imms pointed out some years ago, that the method of biological control is strictly limited in its application. The greatest successes in parasite introductions have been where a peculiarly favourable physical and biological environment exists, such as obtains in remote oceanic islands as Hawaii and Fiji, or in particular continental areas as California, which are physiographically isolated and to be regarded as ecologically insular. Trinidad, in contrast with these, is a recent continental island, which can be regarded ecologically as a part of South America, its fauna being essentially similar to that of the neighbouring part of Venezuela, and affording an unfavourable biological environment for the introduction of parasites. On theoretical grounds and in the present state of knowledge it would be unwise, therefore, to predict any spectacular control of insect pests in Trinidad resulting from parasite introductions.

Insect physiology has come into prominence within recent years and some notable advances have been made in various directions. This has been stimulated by the demand for exact information on such subjects as the reaction of insects to parasites, their adaptation to different physical environments, their nutrition and respiration and the action upon them of insecticides.

Recent work on insect physiology includes studies of carbohydrate and fat metabolism, the nutritional requirements and utilisation of food by larvae, the physiology of the sense organs, the physiological conditions of cold-hardiness and the physiological factors influencing insect abundance. Cold-hardiness in insects has been found to depend upon their physiological state, insects in a diapause being most resistant, those that have had their development arrested by cold but have not entered a diapause being less so, and developing insects showing practically no cold-hardiness.

The abundance of cotton stainers and cotton leaf-worms has been shown to be reduced through a decrease in the fecundity of the females and in the general vitality of the insects due to their diet being deficient in such elements as zinc and copper. Similarly, the absorption of certain elements by plants, directly through the leaf surface or by way of the root system decreases the fecundity of the females of insects feeding on the foliage and should result in the reduction of insect populations over an extended period. Extremely small amounts of selenium absorbed by plants have previously been shown not only to reduce fecundity but to be extraordinarily toxic to various insects. The interesting suggestion has been made that increases in insect populations following the application of fungicides may be due more to a physiological change in the cell sap than to the destruction of entomogenous fungi.

The Department of Zoology and Applied Entomology of the Imperial College of Science and Technology in London has recently come to the fore in the study of insect physiology. This department has distinguished itself in the past in the training of entomologists, the study of insect ecology and the entomological problems of industry, especially those relating to the infestation of stored products by insect pests. The training given to entomologists has always been of a very high order and it is interesting to note that, of some fifty agricultural entomologists employed in the Colonial Empire at the present time, rather more than half received their entomological training in this department.

Professor J. W. Munro, the energetic head of the department, has added materially to its achievements by the direction of its work along physiological lines. Support has been forthcoming from such bodies as the Agricultural Research Council, which, recognising the need for work of this nature, finances both basic and applied work in insect physiology, the latter being concerned with the physiological action of insecticides. This has enabled physiology to be developed in the teaching and research programmes. Interesting work is at present in progress on the factors affecting the rise and fall of insect populations, on the respiration of insects, on the physiology of the phenomenon of diapause or dormancy in insects, on the physiology of reproduction and on the hormones inducing pupation in insects. This imposing list of problems being undertaken by so progressive a department promises well for the development of this important branch of entomology.

E. McC. C.

A TRIBUTE TO SIR GEOFFREY EVANS.

(We reproduce below the verbatim report of Mr. Malcolm MacDonald's speech, at a luncheon on 11th July, given by Mr. Eric Macfadyen, Chairman of the Governors, when Sir Geoffrey Evans, in recognition of his twelve years' work as Principal, was presented by the Imperial College of Tropical Agriculture with a portrait by Miss F. A. de Biden Footner.)

The Secretary of State for the Colonies (Mr. Malcolm MacDonald, M.P.) said: You, Mr. Chairman, have made a flattering reference to the fact that I am here to-day, but I got from you in the private conversation which preceded your public effort the real reason why I was invited to this pleasant task. You said, Sir, that what I said this afternoon might be taken down and used in evidence against me later (*laughter*). I am very happy indeed to have been put in that position. I have a very pleasant part to play. Sir Geoffrey Evans was the Principal of the Imperial College of Tropical Agriculture for twelve years. When he went there the College was comparatively young, inexperienced and unknown; when he retired it was a flourishing institution doing work of the utmost value to the Colonial Empire and enjoying a world wide renown. I do not think that anyone in this distinguished and well-informed gathering would deny that, or that the transformation was due to the personality, organizing ability and capacity for leadership of Sir Geoffrey Evans. He had a great deal to do in the early days with the organization of the work of the College and he planned the courses to be followed by those who went there. He planned a great deal of the research work into the problems of tropical agriculture which the College was equipped to do. Quite apart from planning the actual programme of work and playing a great part in the achievement of the work of the College, he made a unique contribution towards personal relationships and towards getting the very best that was in them out of the staff and the students. He had a number of research workers co-operating together as a very efficient team and he inspired them with real keenness not only for their own scientific work but for the general work of the College. He was not less successful in winning the confidence of the students who came to the College to learn much of the particular work they had to go out to do in the Colonial Empire. That work has produced results of which he must be proud and with which we feel the greatest possible satisfaction. To-day something like one-third of the agricultural officers of the Empire have received training at the Imperial College of Tropical Agriculture. I have often heard them speak of the double debt they have contracted while they were in Trinidad, first to the College and to those who have anything to do with it because of the high standard of training they received there, and the second, a personal debt to Sir Geoffrey Evans and to Lady Evans for the great interest which they always showed in every individual member of the College. It was not only while they were in Trinidad that they had the benefit of association with Sir Geoffrey for I believe that after they left they helped to swell his post bag from many stations in the Colonial Empire to get from him guidance and inspiration in the particular work they have had to do.

It is difficult to exaggerate the importance of the work which our agricultural officers are doing. Our agricultural service is second to none in the value of the work it is doing for the Colonial Empire. The well-being of by far the greater part of the inhabitants of the Colonial Empire is dependent primarily on agriculture and for that reason it would be impossible to exaggerate the importance of the work which the Imperial College is doing, whether it is for students in the West Indies or for that much wider body, the agricultural officers who have gone out to become guides, philosophers and friends in our agricultural territories or those who are engaged in the work of scientific research which is spreading benefits to a large number of the crops agriculturists grow.

I am quite certain that Governments and firms who are interested in tropical agriculture and who have followed the work of the Imperial College of Tropical Agriculture recognize the immense value and the vital importance of the work the College is doing. They all watch the progress of the College with a jealous eye and care very deeply about its well-being. They ought to be prepared to do whatever may be desirable to ensure that the useful life of the College is continued. I commend to them the example of the Carnegie Corporation which has provided £32,000 as the nucleus of an endowment fund.

The Imperial College of Tropical Agriculture is the keystone of the arch of our Colonial agriculture structure and we are here to-day to do honour to the workman who saw that the keystone was well and properly laid in its place. I am not in the least surprised that the portrait has made Sir Geoffrey Evans a work of art for he was a work of art long before the painter's brush got to work. It is a very great pleasure to me to have the privilege, on behalf of the College, of presenting this portrait to Sir Geoffrey Evans. A copy of it will go to Trinidad.

Sir Geoffrey Evans, in reply, paid a tribute to his staff, and described the research work which had been carried through successfully on cacao, bananas and sugar. They dealt with a wide range of scientific matters and scientific research, and at the same time were responsible for training students in tropical agriculture. It would be a catastrophe if the College had to close down, but if it was to go on with its important work its finances should be placed on a sounder basis.

BANANA TRANSPORT: A COMPARISON OF STORAGE CONDITIONS IN A MODERN SHIP AND IN EARLIER TYPES.

By E. R. Leonard.
(*Low Temperature Research Station, Imperial College of Tropical Agriculture, Trinidad, B.W.I.*)

Introduction.

In previous publications from this Station (Wardlaw and McGuire, 1931-a, 1931-b, 1932) the results were given of investigations into the cold storage of Gros Michel bananas both under experimental conditions and those prevailing contemporarily in banana-carrying ships. Since then important modifications have been made in the equipment used in commercial practice. The purpose of the present note is to record some observations made in 1939 on a modern ship equipped for banana transport, the data having been collected as a basis for further experimental storage investigations.

Investigations of Conditions in Banana Holds (1930-1931).

In standard practice, now long-established, the empty holds are cooled down prior to loading fruit, each deck or chamber is closed as soon as loading is completed and the fruit is cooled down by air delivered at 53°F., most modern banana-carrying ships being equipped on the battery system.

In the type of ship calling at Trinidad in 1930-32 a fresh charge of air was blown into the hold, to remove accumulated gas, soon after closing the doors and hatches and thereafter at intervals of 12 or 24 hours. The construction of the air trunks and the disposition of trap-doors and bins were such that inspection *in situ* of the thermometers was possible and "ship-ripe" bananas could be removed from most positions in the holds. The typical banana-carrying ship was divided into four holds each of which was sub-divided into three or four decks (a total of fourteen), the latter varying in size from 20,000 to 35,000 cu. ft.; each hold or pair of adjacent holds was supplied with air from its own cooler and fan, a side to side (thwartships) system of air distribution in the holds being general.

Temperatures were recorded at 6 a.m., noon, 6 p.m. and midnight, and notes on the number of bunches jettisoned, the number of the bin from which they were removed, the estimated number turning and ripe recorded.

Air temperature records from two holds of such a ship are given in Fig. 1, the records having been taken during the first four days of a voyage from Santa Marta. These are typical of several records obtained during 1930. It will be seen that the minimum temperature which fruit nearest the delivery trunk could have attained after a total of 64 hours was 57°F. (In another voyage a delivery air temperature of 52.5°F. was obtained after 52 hours. The carbon dioxide concentrations of Fig. 3 refer to this voyage, those of Fig. 2 to a voyage in which 72 hours were required to establish this delivery air temperature.)

Elsewhere (Wardlaw and McGuire, 1932) it was stated that in some ships reduction of flesh temperature of fruit marginal on alleyways to 56°F. (approximately) was achieved in the course of two days, this being apparently the optimal cooling rate observed.

At that time (*i.e.* 10 years ago) there existed a considerable amount of unfounded prejudice in the Trade against the rapid cooling of bananas, it being held that they were liable to sustain a "shock" if the period of cooling to the storage temperature was not prolonged over three or four days, and that chilling, with concomitant failure to ripen regularly or ripening to a dull colour would result.

Values for carbon dioxide concentration in the banana holds during the initial period of cooling (Fig. 1) are not available but Figs. 2 and 3 reproduce those obtained during two voyages on this type of ship. It will be noted that considerable accumulations of carbon dioxide occurred in the periods between "blowing."

Experimental Investigations on Rapid Cooling and the Limits of Chilling.

Experiments were undertaken during 1930-32 at the Low Temperature Research Station, Trinidad, to determine the limits of chilling for bananas and to examine the possibility of reducing main-stalk rot which was then a serious cause of wastage in cargoes.

The results relating to time of cooling were summarized as follows:—

"In these investigations the object was to define the limits of chilling, with a view to placing on a definite footing our previous recommendations of quick cooling as a preventive measure for main-stalk rot and other sources of fungal wastage in banana cargoes. The storage trials carried out at 51-52°F. have shown that chilling is a cumulative effect of duration of exposure, and not the result of rapid cooling to such temperatures. Our researches have corroborated strikingly our earlier recommendations that 53°F. is definitely not inimical, no matter how quickly it is reached, provided delivery temperature of the air is not lower than this temperature. On the other hand, we have obtained chill effects by:—

(*a*) *Gros Michel.*
- (i) Exposure of 14 days at 52°F.
- (ii) Exposure of 9 days at 51°F.

(*b*) *Cavendish.*
- (i) Exposure of 13 days at 51°F.

Since this work definitely aims at providing information for the Trade, our practice has been the more and more rapid cooling to progressively lower temperatures than those usually adopted,

and we have now established, contrary to previous information, that *the rapid cooling to* 53°F. *within* 12 *hours may be practised without danger of chilling during the usual voyage of* 16 *to* 20 *days. This will bring in its train the advantages of retarded fungal activity, with consequent decrease in wastage.*

While from the purely mycological standpoint the benefits of temperatures lower than 53°F. are evident, we do not recommend them, since in the resultant comparatively slower ripening, fungal activity is responsible for relatively extensive wastage.

The number of ways in which chill effects manifest themselves include : (i) failure to ripen, (ii) poor colour, (iii) russetting, (iv) "green ripeness" and (v) "hard-ripeness".

Latent or dormant infections established while the fruit is still immature may be responsible for extensive wastage if fruit is not expeditiously cooled and quickly ripened. Such diseases cannot be combated by superficial sterilisation of the fingers, but may be minimised by suitable observation of temperature relations." (Wardlaw and McGuire, 1931-b.)

An example of the rate of cooling of bananas at the Low Temperature Research Station is given in Fig. 4 from data obtained recently. (Wardlaw, Leonard and Barnell, 1939.) The conditions of this experiment are summarised as follows :—

Temperature of room before loading	50°F.
Fan run to supply cool air during loading	
Time to load	1½ hrs.
Number of bunches loaded	108
Approximate total weight	5,400 lb. =2.4 tons.
Approximate volume at 40 cu. ft./ton	96 cu. ft.
Flesh temperature on arrival	80-82°F.
Room blown out on completion of loading	15 mins.
Storage capacity of room	890 cu. ft.
Fan delivery { rated	1,200 cu. ft./min.
Fan delivery { observed	590 do.
Rate of change of air—once every	1.5 mins.
Cu. ft. of air/ton/min.	246
Time for room air to reach 55°F.	46 hrs.

It will be seen that the flesh temperature follows very closely that of the air.

Investigations on Conditions in a Recently Equipped Banana-carrying Vessel (1939).

The conditions which obtain in a recently equipped banana-carrying vessel show considerable differences from those investigated in 1931-32. The practice of cooling down the holds prior to loading (to 46°F.) is continued and produces a noticeable reduction in temperature of the pulp of the fruit first loaded into the chamber although the air temperature rises rapidly to that of the outside atmosphere.

The air circulation in the vessels, on board which temperature and carbon dioxide measurements have been made, is from below the deck gratings, cold air being delivered through trunks running along the side of the chamber and subdivided to give even distribution, the return being at the top of the chamber at the end remote from the doors. No provision is made for "blowing out" the air but the chambers are on "constant atmosphere", *i.e.* there is a constant dilution with outside air drawn into the chamber from the top deck of the vessel, an equal volume of foul air being vented between the fan and cooler, provision being made for adjusting the volume of such diluting air by means of baffles. Once loading is completed no access to the banana holds is possible, the only opening being in the delivery trunk close to the cooler, at which point, therefore, samples of the hold air were withdrawn. The refrigerated holds are divided into small chambers of 4,000 to 7,600 cu. ft. capacity, there being eight in all. Each chamber is supplied with air by its own fan and cooler, the fan speed being variable.

Temperatures are recorded at 3 p.m., 9 p.m., 3 a.m., and 9 a.m. from two or more thermometers suspended in tubes (one forward, one aft) in each chamber and, at more frequent intervals, on the delivery and return sides of the fan and cooler. Samples of air from the delivery trunk are tested for carbon dioxide concentration, a range of 0.3 to 0.6 per cent. being permitted.

Fig. 5 gives a record of delivery and return air temperatures for one chamber of such a ship together with values of carbon dioxide concentration of samples of air taken from the delivery trunk. During the period of observation the fan speed was maintained constant (3 H.P. input to motor) throughout and the dilution air baffles full open except for two brief periods.

The temperatures observed in the aft and forward thermometer tubes corresponded very closely to those for the delivery and return air respectively.

The following additional data are appended :—

Temperature of room air before loading	46°F.
Fan stopped during loading.	
Time to load	3½ hours.
Number of bunches loaded	1,719
Approximate total weight	77,960 lb.= 34.8 tons.
Approximate volume at 40 cu. ft./ton	1,390 cu. ft.
Flesh temperature on arrival	78°F.
Flesh temperature of fruit loaded first on completion of loading	73.2°F.
Air temperature on completion of loading	73.3°F.
Bin capacity of chamber	4,100 cu. ft.
Fan delivery—rated at 1½ inches water gauge and 3 H.P. input	8,000 cu. ft./min.
Calculated rate of change of air (neglecting reduced fan delivery due to fractional losses) once every	0.5 min.
Cu. ft. of air/ton/min.	230
Time for return air to reach 55°F.	19 hrs.

No useful observations on humidity conditions in the storage chamber could be made during cooling and storage. During the period of loading the atmosphere remained close to saturation, the woodwork being covered with a film of moisture, this being a result of the preliminary cooling down of the hold prior to loading. Measurements by wet and dry bulb thermometers at the only available point of observation—on the delivery side of the cooler—indicated that the humidity of the delivery air ranged from saturation to 97 per cent. R.H.

Similar values of air temperatures and carbon dioxide concentrations during the first two hours of cooling in holds of sister ships were obtained during brief visits in port.

Conclusion.

Though both operate on the battery system very considerable differences are seen to obtain in the two types of installation.

(1) In the earlier type the holds and, usually, the whole ship, were loaded in one or two adjacent ports whereas the type recently investigated collects bananas in relatively small quantities at a number of ports, a procedure rendered feasible by the sub-division into small refrigerated chambers. The cooling load on the refrigerating machinery is thus spread over a considerable period.

(2) The very rapid cooling observed in the later type is achieved by an increased size of cooler so that the temperature of the delivery air is reduced to 53°F. almost as soon as air circulation is commenced.

(3) No data are available on the distribution of temperature in the chambers of the two types of ship, once the steady storage value has been reached.

(4) The "constant atmosphere" system reduces the carbon dioxide concentration in the hold to very low values, the maximum observed in the present investigation being the minimum on the recommended scale of tolerance.

(5) These findings are of considerable interest and value in relation to the programme of work at this Station which consists in investigating (i) the possibility of improving the quality of banana at present exported, (ii) the application of gas storage and (iii) the improved control of wastage.

(6) The decreased time involved in cooling to the storage temperature has reduced certain types of storage rots to minor importance. It may also render possible the transport of a heavier grade of fruit or of the present grades to more distant markets.

(7) In the present state of our knowledge the reduction in carbon dioxide concentration in the holds may be regarded as desirable in so far as it may be taken as an indication of the concentration of other gases, in particular those volatiles known to stimulate ripening.

Acknowledgments.

The recent investigations detailed above have been made possible through the courtesy of the Canadian National Steamships Company and sincere thanks are due to the engineering staff of the ships visited for their willing co-operation.

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REVIEW.

THE ACTION AND USE OF COLCHICINE IN THE PRODUCTION OF POLYPLOID PLANTS.

By J. L. Fyfe. *Price* 1s.

The discovery of the action of the drug colchicine on nuclear division, making it the most reliable agent yet used in the production of polyploid plants, has excited great interest even in laymen and is of importance to those working on the cytology or genetics of plants.

The Imperial Bureau of Plant Breeding and Genetics, Cambridge, has issued a bulletin on the subject, summarizing the already fairly extensive literature. This bulletin begins by explaining the chromosome doubling; next a detailed account of the action of colchicine on mitosis and meiosis is given, followed by summaries of the results obtained from the use of colchicine for producing polyploid plants. The action and use of acenaphthene, which the Russian workers have shown to be a similar agent to colchicine are also described. Particular attention has been paid throughout to treatments and dosages and some recommendations are given which should be helpful to those contemplating the production of polyploids. All the literature appearing up to the end of January 1939 is included and listed in a bibliography of 38 references.

GROWTH RATE OF CROSS AND SELF-FERTILIZED CACAO.

O. J. VOELCKER.
(*Agricultural Department, Nigeria.*)

AN easy method of obtaining self-fertilized cacao seed in quantity for distribution can be arranged by planting an isolated clonal block of the parent tree from which seed is required. The original scheme for cacao work in Nigeria, initiated in 1931, embodies the use of this method. A copy of the scheme was, however, forwarded to Professor E. E. Cheesman of the Cacao Research Station, Trinidad, for his comments. Among these was the most helpful suggestion that no consideration had been given to cross-fertilized seed which might well show marked increase in vigour over plants grown from self-fertilized seed. Although there was no evidence that this was so, the possibility was considered sufficiently important to warrant experimentation, and a trial was consequently instituted. The layout of this experiment was submitted to Professor F. L. Engledow and to Dr. J. Wishart for their criticism, and the final design is the result of their advice.

Parent Trees.

Ten trees from among the Nigerian selections were chosen. A description of these trees has been given elsewhere (1), and it will be remembered that they are probably a first cross between *Theobroma leiocarpa* Bern. and a hybrid type. The dominant characteristics are of the *leiocarpa* species, and in pod size and shape there is little variation.

The Lay-out.

With ten parent trees it is possible to obtain 90 different crosses, but it was not considered necessary to include all, which would, indeed, have made the layout too cumbersome. It was practicable only to allocate 800 stands to this experiment, and the number of crosses was reduced to 15, in which each of the ten trees occurs at least once both as male and as female parent. With this stipulation the 15 crosses were chosen by drawing, and they include by chance two reciprocal crosses.

The ten trees were :—

Nos. 13, 213, 30, 50, 86, 190, 184, 38, 35, 9.

The 15 crosses were :—

Nos. 9×(30), 190×(184), 50×(30), 190×(13), 50×(213), 38×(184), 35×(86), 30×(190), 184×(86), 86×(35), 13×(9), 13×(38), 213×(50), 35×(213), 38×(9).

The male parent is in parentheses.

In a plot of 25 stands, each cross and each selfed parent occurs once, their position within the plot being randomized. Sixteen randomized plots form one block of 400 stands. One such block was established at Moor Plantation, Ibadan, another at the Owena cacao experiment farm in Ondo Province.

Technique of Cross-pollination.

Only the flowers of the stigmatic parent were guarded, and no emasculation of them was attempted. Flowers from the pollen trees were carried to the flowers of the stigmatic parents, and pollination was performed by the direct application of the anthers to the stigma. No difficulty was experienced in obtaining a high percentage of setting. Pollination was confined to the months of May and June, 1934, so that the resulting seedlings were of uniform age.

Establishment.

Seeds from the self and cross pollinated pods were planted in baskets, watered during the 1934-35 dry season, and set out at 15′ × 15′ in June, 1935, under banana shade at Ibadan, and in July, 1935, at Owena. No difference in vigour had been noticed in the nurseries between the two classes of seedlings. During the ensuing and subsequent dry seasons a number of deaths occurred (largely due to faulty planting technique), and the stands have been supplied annually with the appropriate material. Cultural operations at Ibadan and Owena have been confined to shade control and vegetable mulching.

Determination of Vigour.

While the merits of self and cross pollinated cacao plants must await the statistical examination of yields from these two classes, it was thought possible to obtain some indication of the relative growth vigour before such yield records became attainable. It would be logical to assume that the more vigorous class would be more easy to establish. And once established it would show a more rapid growth rate. With this in view, stem diameter measurements were made at Ibadan at six weekly intervals, but owing to supervision difficulties at Owena, no such recording was possible. Measurements at Ibadan were commenced in August, 1935, and were continued till March, 1939. All measurements were made to the nearest millimeter with wooden callipers at the cotyledonary node. This node was marked from time to time with white paint.

Results.

The losses in establishing were as follows :—

Table I.

	IBADAN			OWENA.		
	No. Planted.	No. Dead.	Percentage Dead.	No. Planted.	No. Dead.	Percentage Dead.
Crossed	240	120	50	240	158	66
Selfed ...	160	72	45	160	84	53

Totals.

	No. Planted.	No. Dead.	Percentage Dead.
Crossed ...	480	278	58
Selfed ...	320	156	49

The growth rate measurements are recorded in Table II as mean square diameters of the 120 crossed plants and of the 88 selfed plants. These are the stands at Ibadan which have never required supplying. Graph I represents diagrammatically the growth rates.

The measurements taken on 19th January, 1939, were subjected to statistical examination. The difference between the mean square diameters of the crossed and selfed plants at that date was not statistically significant, (t=.9257; for a significant difference, P=.05, t should be greater than 2.). Since this difference, taken at the end of the period of observations, is not significant, it suggests that there has been no significant difference in the rate of growth during the previous three and a half years. From an examination of the graph, the similarity of growth rate for the first two years is obvious.

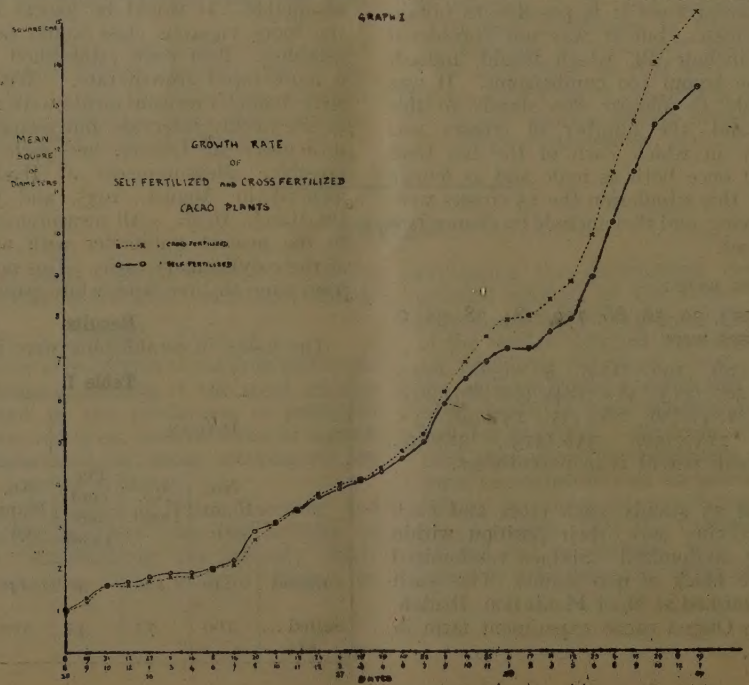
Discussion.

It is generally recognized that cross fertilization between different varieties of most plants leads to hybrid vigour in the offspring. The population of ten trees, from which the breeding results have been obtained, include what may be termed only one variety. Very different might have been the results had crosses been made within a

Table II.

Date.	Mean Square of Diameter.	
	Crossed.	Selfed.
8. 8.35 ...	1.0	1.0
19. 9.35 ...	1.2	1.3
31.10.35 ...	1.6	1.6
12.12.35 ...	1.6	1.7
23. 1.36 ...	1.7	1.8
5. 3.36 ...	1.8	1.9
16. 4.36 ...	1.8	1.9
8. 6.36 ...	2.0	2.0
14. 7.36 ...	2.1	2.2
20. 8.36 ...	2.7	2.9
1.10.36 ...	3.1	3.1
12.11.36 ...	3.4	3.4
24.12.36 ...	3.8	3.7
4. 2.37 ...	4.0	3.9
18. 3.37 ...	4.1	4.1
29. 4.37 ...	4.4	4.3
10. 6.37 ...	4.8	4.6
22. 7.37 ...	5.2	5.0
2. 9.37 ...	6.2	5.9
14.10.37 ...	6.9	6.5
25.11.37 ...	7.5	6.9
6. 1.38 ...	7.9	7.2
17. 2.38 ...	8.0	7.2
31. 3.38 ...	8.4	7.6
12. 5.38 ...	8.8	7.9
23. 6.38 ...	9.9	8.9
4. 8.38 ...	11.4	10.2
15. 9.38 ...	12.6	11.4
27.10.38 ...	14.0	12.5
8.12.38 ...	14.6	12.9
19. 1.39 ...	15.2	13.4

GRAPH I



population showing a greater degree of variation. At the same time, it is comforting to have the indication that self-fertilization of the Nigerian selections is not leading to the production of weaker plants, and consequently that seed from isolated monoclone plots may be distributed with confidence.

Owing to the severe losses in establishment, it is not possible to judge the relative vigour of the particular crosses with any degree of accuracy. To do so, a number of years of yield recording must elapse.

Summary.

The cross-fertilized progeny of ten Nigerian selections showed no significant increase in vigour over self-fertilized progeny from the same trees. But hybrid vigour might have been noticed had there been more variation among the selections.

Acknowledgments.

This work was initiated at the suggestion of Professor E. E. Cheesman, Imperial College of Tropical Agriculture, Trinidad, and the writer wishes to record his appreciation of the interest taken by Professor Cheesman in proposing such an experiment. To Professor F. L. Engledow and to Dr. J. Wishart, School of Agriculture, Cambridge, the writer is deeply indebted for the time and trouble taken in revising the experimental layout. The stem diameter measurements were, for the most part, made by Messrs. E. J. Spiff and S. A. Amole, African Technical Assistants, to whom the writer is grateful. Mr. G. K. G. Campbell, Agricultural Officer, very kindly examined the results for statistical significance. In times of severe financial stringency, Capt. J. R. Mackie, Director of Agriculture, has made funds available for carrying on this work; for doing so and for permission to publish this paper the writer is greatly indebted.

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THE DETERIORATION OF FAT IN FOODS.

Dr. C. H. Lea, of the Low Temperature Research Station, Cambridge, in an article published in *Chemistry and Industry** on the deterioration of fat in foods, discusses the three 'internal' factors capable of influencing the development of oxidative rancidity in fats. By the term 'internal' factors the author understands those factors which can be regarded as inherent properties of the natural raw material and includes in this category the inherent reactivity towards oxygen of the glycerides themselves, the protective action of natural anti-oxidants and the harmful effect of natural pro-oxidants or oxidizing enzymes.

The liability to undergo oxidation is characteristic of all fats, animal and vegetable, and the avidity with which an unsaturated fatty acid or ester combines with oxygen increases with the number of double bonds. This relationship between the degree of unsaturation and the rate of development of oxidative rancidity should be of particular interest in the case of the body and milk fats of domestic animals where a certain amount of control over composition can be exercised by feeding. Butter fat or lard, for example, can be varied under extreme conditions from hard solids to semi-liquid or even liquid fats.

In the fats themselves and in the tissue surrounding the fats there are commonly found natural anti-oxidants that prevent oxidation and enzymes or organisms that promote oxidation. The anti-oxidants are present in the unsaponifiable fraction of the oil and prevent the oxidation reaction attaining its maximum velocity until they themselves have been destroyed. Usually only a small proportion of the total amount of inhibitor present is extracted with the oil, the remainder staying behind in the cake. Little is known about the nature or origin of the natural anti-oxidants though it has been suggested that in the vegetable fats some at least of these vegetable concentrates are the tocopherols. It is probable however that anti-oxidants of a considerable number of different types occur in nature. The origin and nature of the anti-oxidants of animal milk and body fats are at present quite unknown.

It is only recently that oxidizing enzymes have come to be regarded as potential accelerators of oxidative rancidity in foodstuffs. Evidence for the existence of fat-oxidizing enzymes in vegetable tissues has practically been limited to reports of cases in which heat treatment has been found to increase the stability of the fat. In the case of animal products more data have recently become available and evidence has been produced to show that milk contains an enzyme 'oleinase' which accelerates fat oxidation. The presence of an oxidizing enzyme in the flesh of the herring and the adipose tissue of the pig has also been demonstrated.

H. F. B.

* *Chemistry and Industry*, Vol. LVIII, No. 20, p. 479, 1939.

NOTE.—With regard to the natural anti-oxidants in seed meals it has recently been shown by T. P. Hilditch and S. Paul (*J. Soc. Chem. Ind.*, 1939, LVIII, 21-24) that these compounds show marked reducing power, which suggests the presence of reducing carbohydrates. The authors believe that they have established the fact that seeds contain natural anti-oxygenic compounds characterised by their basic or pseudo-basic nature, and that there is some reason to believe that basic oxygen may be the responsible factor for retardation of atmospheric oxidation.

WEALTH FROM THE DUSTBIN.

By R. D. Anstead, M.A., C.I.E.

Introduction.

In the February 1938 issue of this Journal* an account was given of the "Hyganic" process for converting town wastes into fertiliser. The writer has recently paid a visit to a factory established at Wood Green Lane, London, to deal with the refuse of the Kensington area, and the following account of it may be of interest.

All the refuse collected from the houses in the Royal Borough of Kensington is delivered free by the Municipality at the factory, which then disposes of it. The Municipality pay the factory a subvention per ton for this service. It used to cost the Municipality considerably more than this subvention to collect and dispose of their house refuse, and most of this expenditure was due to disposal as it had to be taken down the river estuary to be dumped on marsh land. Now the Municipality benefits to a great extent which is to the advantage of the rate payer.

The refuse is now dumped at the factory into large pits at the base of towers, direct from a tarred roadway. Above the pits the openings are closed by big rubber curtains so that there is no dust and very little smell, and all is quite clean. No trace of refuse or dirt was to be seen outside on the road at the time of my visit, when dumping was finished, and the refuse could only be seen by opening the curtains.

Method cf Sorting.

The refuse from the pits is raised by grabs to the top of the towers above the pits. Nothing falling from the grabs can get outside, the curtains at the base preventing this, nor can the working be seen from the outside without opening the curtains. At the top of the building the grab delivers the refuse through a hopper on to screens which pass it on to sorting belts moving through a special sorting room. This sorting is in charge of a specialist who has reduced it to a fine art. It is hand picked, and out of it is taken :—

(*a*) *Bottles.*—These are not cleaned, but there is a ready sale for bottles of all kinds just as they are. They go to a firm which cleans and resells them, and they fetch a good price.

(*b*) *Broken Glass.*—This can be readily disposed of to glass makers at a fair price.

(*c*) *I ags.*—These are graded into woollen, cotton, old sacking, &c., and baled. Most of them go to Lancashire. Woollens fetch the best price, and are used for shoddy. Cottons are used for wipers and cotton waste for mechanics. Sacking and low grade rags are used for making roofing felt, &c.

(*d*) *Paper.*—Newspapers are baled, and so is cardboard. Surprisingly enough all old clean paper fetches a good price.

(*e*) *Old Iron.*—This is the most difficult material to get rid of but it can be sold.

(*f*) *Tins.*—These are sold as they are, and are sometimes detinned before being baled and sold to iron foundries.

(*g*) *Wood, etc.*—The only materials for which there is no sale. These have to be burned.

(*h*) Considerable numbers of old motor tyres and rubber boots appear, and these sell quite well for reclamation, especially of the cotton packing of the former.

The revenue obtained from these waste materials is considerable and more than pays for the sorting work. It can in fact be a profitable side of waste disposal.

Crushing.

The sorted material goes from the tables into a hopper and is conveyed by a moving band to big rotating crushing machines of special make, electrically driven. These are costly, but very efficient. They crush the material fairly finely and at the same time sieve out the coarse ash and cinders. The machines are completely enclosed and no dust gets outside, and they run comparatively quietly. They work the material down to a sort of pulp.

Fermentation.

The crushed material gravitates to moving bands and is conveyed to fermenting cells, and on the way it is sprayed with a culture. No water beyond the culture solution is added, the material being damp to the touch. This is of great interest considering the difficulties which have been raised by critics about moisture content.

From the conveyor the material, now mixed with a culture, falls into a series of cells, which are big brick-lined, bitumen coated pits, closed at the top by close fitting, folding pent-house lids, which form the roof of this part of the factory. Each cell holds 200 tons of material which falls into it from the conveyor through a moveable hopper so that it can be evenly distributed. When full the lid is closed and air is driven through the mass from below by electrically driven compressors. Here it lies for sixteen days, by which time fermentation is complete. A great deal of heat is generated during the process and the temperature runs up to 170°F., but is not allowed to exceed 175°F. Thermometers are installed so that the temperature can be read from time to time. Gases, CO_2, etc., are carried off by flues. There is no smell and nothing to be seen but a series of these cells arranged side by side with their closed lids along the roof of the building.

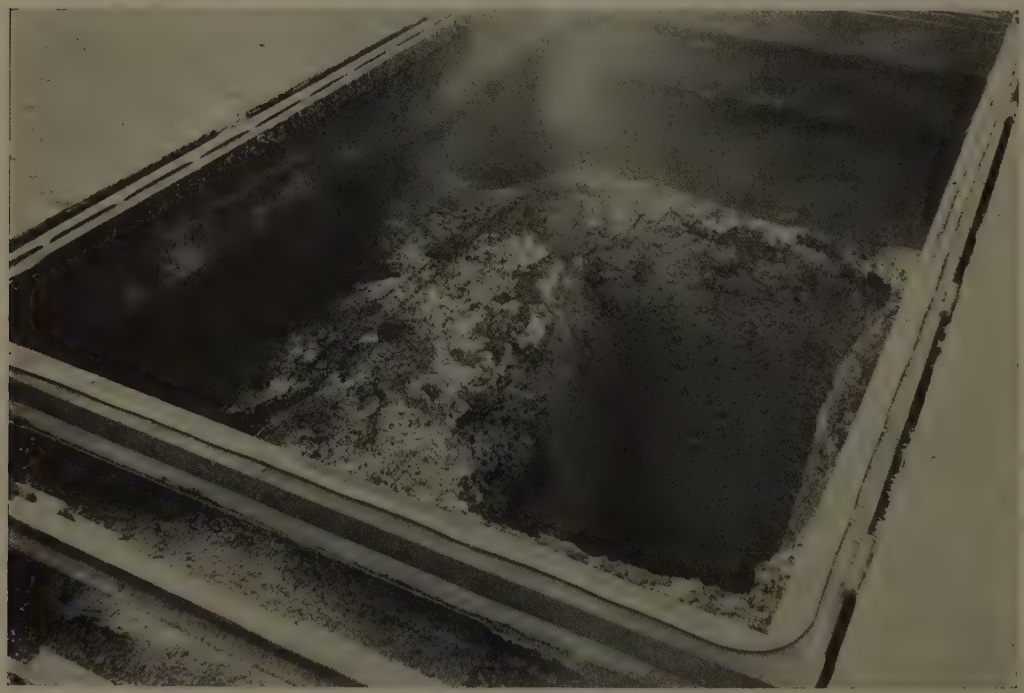
* Waste Not, Want Not.—*Tropical Agriculture*, XV, No. 2, p. 25.

By courtesy *Mitchell Engineering, Ltd.*

FIG. 1.—General view of factory. In the building on the left will be seen the doors, protected by their rubber curtains, through which the crude refuse is delivered. At the top of this building is the sorting room. The sorted material passes to the central building containing the crusher and compressors. The crushed material is then passed, being inoculated on the way, to the series of fermenting cells seen on the right, above which is the travelling grab by means of which the finished material is delivered to the lorries.

By courtesy *Mitchell Engineering, Ltd.*

FIG. 2.—The crude material in a receiving hopper, showing the grab by means of which it is raised to the sorting room on the top of the building. Note the tins, paper, baskets, &c.



By courtesy *Mitchell Engineering, Ltd.*

FIG. 3.—The finished material in the fermenting cell. Part has just been removed. Note steam and the white fungous mycelium, and contrast with Fig. 2.

At the end of sixteen days the lid is opened and the material, now completely composted to a friable mass containing about 25 per cent. of moisture, is removed by an overhead grab and dumped into lorries for transport to the farmer or market garden. The mass sinks some three feet in each cell during fermentation. When being emptied there are clouds of steam as the grab works into the material, and it rapidly dries. There is again no objectionable smell.

The Culture.

The culture with which the material is sprayed is controlled and made by a chemist in charge, who has a small laboratory, and who is doing a certain amount of biological research work. The exact nature of the culture was not disclosed but it consists of a mixture of bacteria and fungi, probably obtained by extracting the finished compost. Inoculation with this culture is considered necessary and desirable in order to ensure smooth working and a constant product of a satisfactory nature, and this is a correct view, as some sort of "starter" is sure to be necessary.

General.

The whole lay-out is very neat and satisfactory. There is no dirt and everything, including the conveyors, is enclosed so that only through opening doors, &c., can one see the material.

In the original process as described in the Journal the crushed material was first subjected to a period of anaerobic fermentation. This has now been abandoned as not only unnecessary but unsatisfactory. The process is now aerobic throughout.

Three hundred tons of refuse are delivered at the factory each day, and this works down to about two hundred tons of compost. The process is continuous, there being a sufficient number of cells to allow each day's delivery to be composted and remain in the cell for sixteen days before removal. There is a sufficient number of cells in series side by side to allow for this with several spares. All the power used is electric.

The Compost.

The chemical composition of such compost as this is variable, depending upon the nature of the daily refuse delivery. Moreover the mechanical difficulty of taking a really representative sample will be appreciated by a chemist. On the average however it contains :—

40 per cent. to 50 per cent. organic matter.
25 per cent. to 35 per cent. mineral matter.
23 per cent. to 27 per cent. moisture.

and the dry matter contains 0.8 per cent. to 1.5 per cent. of nitrogen. Its volume-weight ratio is 2.25 cubic yards per ton.

The agricultural value lies in the fermented organic matter it contains as a basis for soil humus.

Certain preliminary trials have been made with it at Rothamsted, Woburn, Tunstall, Sidlesham, and Reading University, and others are being conducted at various County Agricultural and Horticultural Stations. These have shown that the material is of great value and a good substitute for farmyard manure, the shortage of which is a growing trouble to the market gardener. There is an increasing demand for the compost and little ever remains in stock at the factory, though the demand is naturally apt to be seasonal.

There can be little doubt but that such composts will prove to be useful fertilisers as they are, but the ideal way of using them would be to mix them with farmyard manure in a proportion of two to one and submit this mixture to a further fermentation before applying it to the soil. A compost made in this way should prove of special value to the glasshouse man.

PYRETHRUM PRODUCTION IN KENYA.

Pyrethrum was introduced into Kenya in 1928. As the result of experimental and commercial work its cultivation has greatly increased and in 1936-7 the acreage planted had risen to 4,624, the tons produced to 1,042 and tons exported to 976. It is confined to a few districts lying between 6,500 and 9,500 ft. above sea level. Propagation is by offsets or 'splits' and the plant shows no sign of suffering from the process. Spacing varies from 15×15 in. to 24×30 in., a common one being 18×18 in. The more subject the land is to weed growth, the wider is the spacing. Good drainage is essential or there is liability to trouble from fungous diseases. No manuring has yet been found necessary. Subdivided plants are generally in full bloom four months from planting. There is then continuous blooming which necessitates hand picking of the flowers. These are not picked till they have at least 2 rows of disc florets open. Flowers are dried in an Ainabkoi dryer. The dried flowers are poured into Kraft paper bags which hold about 50 lb. and are sealed with a paper cover pasted over the top. The bags are sent to Nakuru where the material is carefully graded so as to contain not more than 33 per cent. immature flowers or 10 per cent. discoloured flowers and to be free from foreign matter. The approved product is then mixed, baled and again sampled for the guarantee. Analyses show that in transit to Minneapolis, U.S.A., in 1936, there was an average loss of 1.4 per cent. in moisture and of 6.3 per cent. in pyrethrin content. The average pyrethrin content at Minneapolis in 1936 was found to be 1.54 per cent. on the dry basis or 1.42 per cent. in flowers containing 8 per cent. moisture, which compared favourably with the 1.38 per cent. pyrethrin content of pyrethrum from Japan during the same period. A tentative price standard based on these figures in 1937, considerably helped Kenya producers.—(*Hort. Abs.* Vol. IX, No. 2, 1939, *See* also *Industr. Engn. Chem.* (*Industrial Edition*), 1938, XXX, 835-8.)

STORAGE INVESTIGATIONS WITH TRINIDAD GRAPEFRUIT, 1938-39.

By C. W. Wardlaw and E. R. Leonard,
(*Low Temperature Research Station, Imperial College of Tropical Agriculture, Trinidad, B.W.I.*)

I.—Introduction.

In concluding an earlier report (Leonard and Wardlaw, 1937) on the storage of Trinidad citrus fruits it was pointed out that a number of problems of direct practical importance still awaited investigation. Among others, these included (*i*) the determination of the minimum quailing period necessary for grapefruit picked during the wet season and (*ii*) the relation of orchard conditions to storage behaviour, in different localities and on different estates, in conjunction with improvements in orchard sanitation. These problems, particularly (*i*) above, are considered in the present report. With a view to providing information directly relevant to the constructional requirements of pre-cooling stations for citrus in the Caribbean region, the question of rapid cooling has also been made the subject of investigations. As fruit which is to be coloured by ethylene still receives the borax treatment, further data on the effect of this treatment on Trinidad grapefruit are submitted.

II.—Determination of the Minimum Quailing Period for Trinidad Grapefruit during the Wet Season.

(*a*) *The importance of quailing.*

In a previous memoir in this series (Leonard and Wardlaw, 1937) the practice of quailing (wilting or curing) citrus fruits in order to avoid bruising and oleocellosis was discussed. Fawcett (1916, 1936) has given a full account of the cause of this blemish which appears as a "gooseflesh" on the skin and may lead to penetration of fungi or to brown areas following desiccation.

In the earlier memoir it was stated that the normal practice in Trinidad is to quail grapefruit at the estate for 24 hours after picking: it has since been found that considerably shorter quailing is generally given. It was shown by experiments that during the normal dry season (January onwards) quailing at the estate could be eliminated without damage to the fruit. Observations have now been extended to include Marsh grapefruit from different estates picked during the wet season.

(*b*) *Oleocellosis in standard commercial packs.*

Standard commercial packs, containing fruit which had been subjected to the normal packing shed treatment for wet season fruit (*i.e.* borax dip, ethylene colouring, washing, grading and packing) by the Co-operative Citrus Growers' Association, were received at the Research Station four days from the time of picking and examined for oleocellosis. Six crates of fruit were obtained from each of four estates, no special instructions having been given as to time of picking, handling, &c. The incidence of oleocellosis (gooseflesh) is shown in Table I.

Table I.

Occurrence of Oleocellosis (gooseflesh) in Standard Crates.

Estate.*	Weather conditions at picking.	Gooseflesh: number of affected fruits per crate.	Number of fruits in crate.	Gooseflesh per cent.
A	Dry weather, sky overcast.	5	64	
		4	70	
		0	70	
		6	64	
		1	64	
		5	64	
		21 in	396	5
B2	Fruit dry, sky overcast, wet with rain in field boxes	10	64	
		10	64	
		2	64	
		11	64	
		4	64	
		5	64	
		42 in	384	11
C	Dry weather, sky overcast.	10	64	
		6	64	
		6	64	
		10	64	
		3	64	
		7	64	
		42 in	384	11
D	Fruit dry, sky overcast.	7	64	
		19	64	
		4	70	
		10	70	
		5	64	
		5	64	
		50 in	396	12

(*c*) *Oleocellosis and time of picking and transport.*

To determine the effect of (*a*) time of picking and (*b*) duration of quailing before transport, on the incidence of oleocellosis, fruit was picked and transported as nearly as possible according to the following experimental schedule:—

Pick 7 a.m. ("Early")
- Transport without quailing ...Lot 1.
- Quail 6 hours at estate, then transport ...Lot 2.
- Quail 24 hours at estate, then transport ...Lot 3.

Pick 10 a.m. ("Late")
- Transport without quailing ...Lot 4.
- Quail 6 hours at estate, then transport ...Lot 5.
- Quail 24 hours at estate, then transport ...Lot 6.

* The same reference letters are used throughout

In every instance picking took place in dry conditions though the fruit in the earlier picking was still wet with rain or dew. Each lot, consisting of 100 fruits contained in two field boxes, was examined immediately on receipt at the Research Station and the weights of five fruits taken. The sizes ranged from 46's* to 80's*, weighed fruits being all 64's*. The fruit was left in the field boxes exposed to the daily fluctuations of temperature and humidity (75°-85°F., 60-90% R.H.) in the laboratory. Examinations were made 24 hours after picking and after five and twelve days.

Gooseflesh blemishing first appeared within twenty-four hours of picking. No marked increase in the extent of the original blemishes took place later, but additional fruit showed blemishes at subsequent examinations. In no instance was blemishing extensive.

Considering the individual estates, gooseflesh blemishing was considerably less in all lots of the late picking from Estate A than in the early pick and about equal in all the three times of transport for each time of picking. From Estate B1 all early picked fruit showed about the same amount of blemishing which was not reduced appreciably in the late picking nor by delayed transport. Estate C showed consistent differences between times of picking, at least twice the amount of gooseflesh occurring in the early pick: delayed transport decreased the amount in the early picked fruit but had little effect on the later picked fruit. On the whole, therefore, it is clear that the blemishing is related chiefly to time of picking.

As between estates, B1 showed least blemishing at both times of picking and in all transport times followed by C, with A showing considerably greater blemishing especially in the early pick: It thus appears that to reduce this form of blemishing, fruit from A and C should not be picked early (before 10 a.m.) in the wet season but can be transported with little delay, whereas B1 can be picked early and transported without delay.

After five days exposure at tropical temperatures no fungal wastage had occurred in any lot from any estate: after 12 days A showed 11 per cent. of rotted fruit, B1, 5 per cent. and C, 1 per cent. This was almost entirely due to *Botryodiplodia theobromae* and in many instances appeared to follow insect puncturing.

No marked and consistent differences were found in the loss in weight of fruits from different pickings or different estates: considerably more precise methods would be needed to establish differences in rates of loss in weight immediately after picking.

* The sizes given are the fruit 'count' standard as used at the Co-operative Citrus Growers' Association packing-shed and are based on the number of fruit per crate, this being the Florida bulge pack.

(*d*) *Conclusion and recommendation.*

Whilst gooseflesh blemishing does not appear to be a major problem in Trinidad, if the grapefruit is required to pass into the highest grade *attention must be paid to the time of picking during the wet season.* It is a simple matter for each estate to carry out a test on the lines given above to determine the particular picking conditions necessary.

III.—Fungal Wastage in Relation to Locality and Treatment.

(*a*) *Experimental treatments.*

To extend information on this important practical aspect fruit was received for experiment from four estates, A, B2, C and D, and treated as follows:

(*i*) Duplicate lots of 100 fruits, as received directly from the plantations, were exposed unwrapped in the laboratory at the tropical range of temperature and humidity as a means of obtaining as quickly as possible some indication of their liability to fungal wastage.

(*ii*) Duplicate lots of 100 fruits as in (*i*) were exposed unwrapped at 45°F., after a preliminary period of 4 days at tropical temperatures (*i.e.* as would occur in the handling of the crated fruit).

(*iii*) Commercial packs, prepared for export, *i.e.* containing fruit which had been subjected to the borax dip, ethylene colouring, washing, grading and packing (in all occupying four days from the time of picking) were held at tropical temperatures for a total of 12 days, at 60°F. for 9 days and thereafter at 50°F., *i.e.* the fruit was subjected to considerable delay at tropical temperatures prior to shipment (which may happen in Trinidad at the present time) or treated as if it had been subjected to some delay at tropical temperatures followed by non-refrigerated transport—a procedure which we understand has now been discontinued.

(*iv*) Commercial packs as in (*iii*), were placed (*a*) immediately on receipt at the Research Station in storage at 45°F. and 85 per cent. R.H. or (*b*) cooled for 2 days with air at 40°F., then transferred to 45°F.; such fruit may be regarded as exemplifying comparatively expeditious handling.

By this arrangement it was possible to compare the wastage in treated and untreated fruit from four localities during storage at high and low temperatures. The fruit was inspected on receipt at the Research Station and thereafter at intervals. The storage rooms are cooled by the battery system (Wardlaw, Leonard and Watts, 1938).

(*b*) *Effect of storage treatments.*

The record of results is given in Table II.

Table II.

FUNGAL WASTAGE IN GRAPEFRUIT.

(*Results stated as percentages.*)

ESTATE.		A.		B2.		C.		D.	
No. of days ex tree.		22 days.	35 days.	22 days.	35 days.	22 days.	35 days.	22 days.	35 days.
Pre-storage treatment.	Storage.								
(i) Fruit unwrapped and uncrated : no packi g shed treatments	At tropical temperatures	5	15	4	13	1	3	0.5	2
(ii) Fruit unwrapped and uncrated : no packing shed treatments.	4 days at tropical temps. then to 45°F.	0	0	0	0	0	0.5	0	0
(iii) Commercial packs	12 days at trop. temps., 9 days at 60°F.; thereafter at 50°F.	15	20	19	24	15	18	8	10
(iv) Commercial packs	(a) 4 days at trop. temps., then to 45°F.	0	0	1	1	0	1.5	0	0
	(b) 4 days at trop. temps.; cooled with air at 40°F.; then to 45°F.	0	0	0	0	0	0	0	1

Table III.

PERCENTAGE WASTAGE AFTER 35 DAYS.

Estate.	Pre-storage Treatment.	Storage.	*Botryodiplodia theobromae.*	*Colletotrichum gloeosporioides.*
A	(*i*) None	Trop. temps.	14.5	0
	(*iii*) Borax, ethylene, &c.		6	14
B2	(*i*) None	12 days trop. temps., 9 days 60°F., then 50°F.	13	0
	(*iii*) Borax, ethylene, &c.		5	19
C	(*i*) None	do.	2	1
	(*iii*) Borax, ethylene, &c.		4	13
D.	(*i*) None	do.	1.5	0
	(*iii*) Borax, ethylene, &c.		0	9

Considerable differences in the amount of fungal wastage in fruit from different estates are indicated by these observations. The very satisfactory control of wastage that attends rapid cooling to 45°F., after minimum exposure at tropical temperatures, is apparent. Whereas in treatment (*iii*) the effect of the borax dip was to bring about a very marked increase in wastage compared with untreated fruit (*i*) and (*ii*), this was almost completely suppressed in fruit held up to 31 days at 45°F. (treatments (*iv*-a) and (*iv*-b)) (*see* next sub-section).

(*c*) *Effect of borax and ethylene treatments.*

The considerable fungal wastage observed in treatments (*i*) and (*iii*), Table II, was associated with exposure to high temperatures, but whereas in treatment (*i*) the over-all exposure to high temperatures was more prolonged than in (*iii*), the total wastage in fruit from all four localities was consistently less. Moreover, as shown in Table III, the proportion of wastage caused by different pathogens was quite dissimilar in the two treatments.

It will be seen that in untreated fruit held at tropical temperatures practically all fungal wastage was caused by *B. theobromae*, whereas in fruit which had been dipped in borax solution and coloured by treatment with ethylene, the chief cause of wastage was *C. gloeosporioides*. It will also be noted that in fruit from those estates (A and B2) where *B. theobromae* was apparently abundant, treated fruit showed a decrease in this type of wastage. This may be attributed to the ethylene treatment which causes the stem-button (in which *B. theobromae* is harboured) to drop out, a means of controlling this type of wastage already advocated by Smith (1932) and other investigators.

The high percentage of *Colletotrichum* wastage which follows the borax treatment, previously observed in investigations undertaken at this Station (Wardlaw and Leonard, 1937) has been fully confirmed. This is particularly evident in fruit exposed for any length of time at tropical temperatures. But even in fruit stored at 45°F. after only a brief exposure at tropical temperatures, the effect of the borax dip, though masked for approximately 4 to 5 weeks as far as *C. gloeosporioides* is concerned, is nevertheless productive of a serious brown blemishing at the button end which would considerably decrease the market value of fruit. Relevant data are given in Table IV.

It may be noted that after a storage period of 31 days at 45°F., the first evidence of typical *Colletotrichum* wastage began to appear. Prior to this, the effect of the borax (*plus* ethylene) treatment had been to bring about a large amount of blemishing, usually round the button but also laterally where small superficial injuries had been sustained during handling. These blemishes which have been briefly described before (Wardlaw and Leonard, 1937), are of a medium brown colour and are quite characteristic and dissimilar to those produced during the direct desiccation of untreated fruit. Moreover, it is to be noted that in untreated, uncrated fruit exposed at 45°F., the type of blemishing under discussion was entirely absent. In the later stages of desiccation and fungal wastage, however, greater difficulty may be experienced in distinguishing the types of blemish (Leonard and Wardlaw, 1937).

The first indication of blemishing following on the borax treatment consists in the occurrence in a ring round the stem-button, of what may be described as a sub-hyaline appearance in the tissues. On further storage the affected tissues acquire a medium to ruddy brown colour. At high temperatures, since this apparently coincides with the development of latent infections of *C. gloeosporioides*, the green discoloration produced in the albedo by the fungus can be seen on cutting the fruit. On the other hand, in fruit placed at 45°F. after only a brief exposure at tropical temperatures, the brown blemish extends so as to make a conspicuous blotch round the button. In such fruits it is only after 4 to 5 weeks that evidence of *Colletotrichum* development can be observed, but thereafter all such blemishes typically show infection by this pathogen. That this injury is not a normal type of desiccation, but is associated with chemical injury, is clearly indicated by the fact that in comparable lots of fruit, from the same localities, but untreated, and exposed for 35 days at tropical temperatures, during which time they became noticeably slack from loss of moisture, no localised blemishes of this type were observed.

Table IV.

C. GLOEOSPORIOIDES WASTAGE AND DESICCATION BLEMISHING AFTER 35 DAYS IN FRUIT WHICH HAD RECEIVED BORAX TREATMENT. (RESULTS STATED AS PERCENTAGES.)

Storage Treatments.	Wastage.	Estate.			
		A.	B2.	C.	D.
Fruit stored at tropical temperatures	*C. gloeosporioides*	14	19	13	9
	Brown blemishes	0	1.5	0	0
Fruit stored at 45°F.	*C. gloeosporioides*	0	0	1	0
	Brown blemishes	19.5	30	33.5	30

In concluding this section it may be mentioned that *Penicillium digitatum* and *P. italicum*, for the control of which the borax treatment is specially applied, were of very occasional occurrence in either treated or untreated fruit, whether held at high or low temperatures.

(*d*) *Notes on Botryodiplodia theobromae.*

The development of wastage caused by *Botryodiplodia theobromae* at tropical temperatures is illustrated in Fig. 1 for fruit from the four estates. This fungus is of particular importance where fruit has to be held at high temperatures for any considerable period before being placed in cold storage.

It will be seen (i) that little *Botryodiplodia* wastage developed until after the 15th day, (ii) that on fruit from two of the estates, A and B2, it developed more rapidly as from the 22nd day, and (iii) that on fruit from the other two estates wastage was still less than 5 per cent. on the 40th day.

Information on the parasitism of *B. theobromae* on grapefruit is still inadequate; further investigations are now being undertaken by the College Department of Mycology. The factors involved may include, among others, the stage of maturity of the fruit, its intrinsic resistance to fungal attack (this being dependent on a complex of physiological factors), and the distribution and condition, in respect of germination, of the conidia of the pathogen.

IV. Observations on Rate of Cooling and on Chilling in Exposed and Crated Grapefruit.

(*a*) *The need for investigations on the cooling of Trinidad grapefruit.*

The advantages of rapid cooling of perishable foodstuffs are well known and the practice of such pre-cooling has been the subject of considerable investigation. A summary of the pre-cooling of fruits in different countries of the world is given by Smith (1937); Part IV, Section 9, pp. 50-52, deals in particular with citrus fruits. Whilst pre-cooling is the standard practice in the larger citrus producing countries it has only exceptionally been applied in Trinidad. It has been ascertained that for Trinidad grapefruit cooling by air delivered at 45°F. and storage of crated fruit at that temperature are not attended by chilling injury, whereas storage at 40°F. makes for the rapid development of superficial blemishes by which the appearance of the fruit is adversely affected.

In order to obtain data on the specifications for pre-cooling plants for the West Indies, investigations were required to ascertain:

(i) whether any considerable advantage would be gained by pre-cooling to 45°F. by delivering air into the storage rooms at lower initial temperatures; and

(ii) whether such cooling could be achieved without incurring the risk of chilling fruit exposed to the lower temperatures.

To explore these questions a number of cooling and storage experiments have been carried out with the results described below.

(*b*) *Rates of cooling of exposed fruits.*

Fig. 2 shows the record of temperatures of individual fruits, obtained from mercury-in-glass thermometers inserted in the pulp, when the fruits were exposed directly opposite the air delivery ports in storage rooms maintained at 40° and 45°F. It will be noted that in both rooms the fall in temperature to approximately 50°F. was very rapid, and thereafter became asymptotic. But whereas the pulp temperature fell to 45°F. with air delivery at 40°F. after 4 hours, a period of 9 to 10 hours was required with air delivery at 45°F. Because of the additional heat losses due to evaporation at the surface of the fruits, the pulp temperatures in both rooms eventually fell below their respective air temperatures. This was particularly marked at 40°F. where the relative humidity was 78 per cent. as compared with 88 per cent. in the room at 45°F.

(*c*) *Rates of cooling of crated fruit at 40° F.*

Eight standard grapefruit crates were stacked in a storage room at 40°F. Thermometers were inserted into fruits (i) in crates fully exposed to the delivery air and (ii) in crates stacked so as to be comparatively sheltered from the direct effect of the delivery air.

Fig. 3 gives the pulp temperatures observed in four positions, two permitting of rapid cooling (1 and 2) and two of less rapid cooling (3 and 4). It will be noted that in 2 and 1 pulp temperatures fell to the level required for storage, *i.e.* 45°F. after 16 and 20 hours respectively; in 3 and 4, a pulp temperature of 45°F. was reached in crate 3 after 22 hours and in 4, the most sheltered, not till after 36 hours. Fruits exposed on trays in the centre of the room showed rapid cooling, though not quite so rapid as illustrated in Fig. 2 for fruits placed close to the air delivery ports.

After an exposure of 24 hours to air at 40°F. pulp temperatures of fruits occupying different positions within the crates were observed, Table V.

Table V.

PULP TEMPERATURES OF FRUIT IN DIFFERENT POSITIONS IN CRATES AFTER 24 HOURS COOLING.

Position in Crate.	Crate 2. (Most rapid cooling) Temperature °F.	Crate 4. (Least rapid cooling) Temperature °F.
Top layer	41.4	47.3
2nd layer	43.1	47.8
3rd layer	46.1	49.0
4th layer	49.4	47.6
Lower side, on deck grating	—	44.8

These data, obtained from single crates containing 70 fruits, afford some impression of the considerable range in actual fruit temperatures which may be encountered in different parts of a storage room during the initial cooling period. In crate 2, fruits abutting on the slats and at 41.4°F., would be liable to wastage as a result of chilling, while fruits in an inner or protected position still remained 4.4°F. above the required temperature. The resistance which the tightly packed crates of wrapped fruits offer to the penetration of the cold air is clearly indicated by these records.

Two crates, 1 and 3, at an initial temperature of 78°-80°F., were cooled for 42 hours with air delivered at 40°F.: at the end of that period the following observations on pulp temperatures were recorded, Table VI.

Table VI.

PULP TEMPERATURES WITHIN CRATES AFTER 42 HOURS AT 40°F.

Position in crate.	Temperature °F.	
	Crate 1.	Crate 3.
1st layer	40.3	—
2nd layer	42.5	42.1
3rd layer	42.1	42.9

Crated fruit and also trays of exposed fruit which had been rapidly cooled by air delivered at 40°F. were transferred to a storage room at 45°F. The storage records, incidence of chilling, &c., are considered in sub-section (*e*).

(*d*) *Rates of cooling in crated fruit at 45° F.*

In an experiment comparable with that described above, crates were cooled in a room at 45°F., with the results shown in Fig. 4. Pulp temperatures for two fruits are given during cooling at 45°F. (5 and 6) with two at 40°F. (1 and 2) for comparison.

It will be seen that whereas with air at 40°F. cooling to 45°F. of the pulp of fruits abutting on the slats was achieved in 16 to 20 hours, this did not occur until after 48 to 52 hours with air at 45°F. As fruits in more central positions within the crates would remain at still higher temperatures for some considerable time, the advantages of cooling with air at 40°F. during the first 20 hours are evident, *provided chilling injury does not result from such exposure.* As the resistance offered by a stack of crates to cooling by the battery system is quite considerable it follows that air delivery at 45°F. may be attended by comparatively slow rates of cooling of crates in sheltered positions (crate 4, Fig. 3).

(*e*) *Observations on chilling.*

The symptoms of chilling in Trinidad grapefruit have already been fully described (Leonard, 1936; Leonard and Wardlaw, 1937). In crated and uncrated fruit receiving the experimental treatments indicated in Section III (*a*) the following observations were made on the incidence of chilling:

(i) Wrapped and crated fruit, from four localities, when subjected to rapid cooling by air at 40°F. for 24 hours, or in some instances for 42 hours (*i.e.* until all fruits in proximity to the crate slats had a pulp temperature of less than 45°F.), with subsequent storage with air delivery at 45°F., for the most part showed no evidence of chilling after 18 days in cold storage. In one crate of fruit from Estate C (24 hours at 40°F.) and in one from Estate B2 (42 hours at 40°F.) 6 per cent. slight chilling was observed.

(ii) Unwrapped fruit exposed at 40°F. and 78 per cent. relative humidity for 24 hours and then removed to 45°F. and 88 per cent. relative humidity, showed the following percentages of chilled fruit after 18 days:

Estate A	....	12
Estate B2	....	32
Estate C	....	18
Estate D	....	23

(iii) Unwrapped exposed fruit held (*a*) continuously at 40°F., and (*b*) at 45°F. after 6 days at 40°F., showed the following percentages of chilled fruits after 18 days and 25 days.

Table VII.

PERCENTAGE OF CHILLED FRUIT.

Days in storage.	Treatment.	Estate.			
		A.	B2.	C.	D.
18 ...	(*a*)	0	36	16	24
	(*b*)	8	32	20	20
25 ...	(*a*)	20	68	40	64
	(*b*)	40	92	60	76

In comparing these figures, it is to be noted that whereas after 18 days chilling in (*a*) was very difficult to detect in the majority of fruits, in (*b*) it was such as to be easily observable. In other words, although exposure to 40°F. causes chilling injury, the actual symptoms may remain more or less masked or suppressed until the fruit is removed to a higher temperature. By the 25th day, however, symptoms of chilling had become severe in all affected fruits.

(iv) In fruit exposed unwrapped at 45°F. throughout, the following percentages of chilled fruit were observed after 18 days:

Estate A	....	10 (slight)
Estate B2	....	28
Estate C	....	23
Estate D	....	12

Chilling injury in exposed fruit harvested during the wet season was thus a conspicuous feature at this temperature. It would appear, in fact, that the temperature of 45°F. at present recommended

for Trinidad grapefruit lies just above the critical temperature for chilling, and that where fruit undergoes a further slight reduction in temperature as a result of transpiration (*e.g.* to 44.0°-44.2°F.) chilling injury is sustained.

(v) The data indicate that fruit from some areas is considerably more susceptible to chilling than from others. Combining all the chilling data available from these studies, the following comparison is obtained:

Estate A	*Estate B2*	*Estate C*	*Estate D*
7.5 %	24.5 %	17.0 %	14.0 %

The order of increasing susceptibility to chilling would therefore appear to be:

1. Estate A; 2. Estate D; 3. Estate C; 4. Estate B2.

(*f*) *General conclusions.*

From the data set out above it is evident that the rapid cooling of crated grapefruit stored in stacks may involve considerable risk of chilling. For Trinidad grapefruit grown in different localities and harvested at different times throughout the season, chilling is not usually observed in crated fruit stored even for considerable periods at 45°F. provided air is delivered into the storage rooms at that temperature: on the other hand, it is evident that the chilling temperature for Trinidad grapefruit lies close to this storage temperature. In attempting to obtain rapid cooling, therefore, it follows that the air delivery temperatures should be such that the temperature of fruit in crates most fully exposed to the cold air entering the storage room should not fall below 45°F. With rapid air circulation at a temperature of 40°F., the fruit in crates in proximity to the delivery air ports might be reduced to a temperature of 45°F. within 12 to 15 hours. Thereafter some chilling injury might be sustained if air delivery at 40°F. were to be continued. The rational procedure would therefore be to raise the air delivery temperature to 45°F. after 12 to 15 hours.

The more rapid cooling of crated fruit which can be achieved by delivering air into storage rooms at 40°F. as against 45°F. has already been indicated. There are, however, other considerations which should be taken into account. The following quotations from Smith (1937) are apposite:

"It is often assumed that a great acceleration of cooling can be obtained by using air at temperatures below the safe limit for storage. The saving can be assessed if the assumption is made that the rate of fall of the mean temperature of the stack is proportional to the difference between this mean temperature and the temperature of the delivered air.

"If very cold air could be used for the whole pre-cooling process, the saving in time would often be considerable. [For example, the time to cool from 75° to 35°F., with air at 25°F., would be more than 25 per cent. shorter than the time required with air at 30°F.] Such cold air, however, cannot be used throughout the process, if there is a boundary condition that none of the fruit may be cooled below some higher temperature at which injury may occur".

In experiments to which Smith refers an air temperature 10°F. lower than that required for storage (25°F. for 35°F.) could be used for only about half the cooling range, and would result in a saving in time of only 12 per cent. over this range compared with air 5°F. below that for storage, and considerably less as a percentage of the whole period of cooling to the mean storage temperature (35°F.). He adds that "it is a matter of common observation in the laboratory, that when fruits, unwrapped and unpacked, are brought from outside warm temperatures into cool storage rooms, no immediate injury follows; and the rate at which the temperature changes in these fruits, even though no particular means is adopted to accelerate it, is about as rapid as the maximum rate which can be achieved in commercial practice, in stacks of packed fruit, cooled by a strong blast of cold air".

In the light of these observations it would appear that specifications for citrus pre-cooling stations in the Caribbean region should call for refrigerating capacity such as to permit of delivery of air to the storage rooms at such a temperature that no crate shall be exposed to air at a temperature less than 40°F.; the cooling schedule also must be arranged so that as soon as fruit in the crates which cool quickest reaches the storage temperature (45°F.), the temperature of the delivery air is raised to obviate chilling injury. Smith (1937) gives details of pre-cooling and storage plants in South Africa and elsewhere and comments upon their advantages and disadvantages. Comparison may be made with data obtained from an existing cold store in Trinidad not specially adapted for pre-cooling of grapefruit (Leonard, 1936. Appendix).

V.—Summary and Conclusions.

1. Storage investigations with Trinidad grapefruit harvested during the wet season are described, special attention being directed to a determination of the time of picking and the minimum quailing period required to avoid oleocellosis (gooseflesh), to fungal wastage in relation to locality, packing-shed and storage treatments and to rates of cooling and incidence of chilling under different experimental conditions.

2. With the harvesting and transport procedures current among certain planters, more than 10 per cent. of fruit may suffer from the type of superficial blemishing known as "gooseflesh" (oleocellosis) which results from the rupture of oil vesicles in the skin due to handling fruits in a highly turgid condition. The liability to oleocellosis has been shown to vary from estate to estate, its intensity being chiefly determined by the time of picking, and, to a minor extent only, by the duration of the

quailing period before transport of fruit from estate to packing shed. The liability to oleocellosis can easily be determined on the spot by simple experimental observations.

On estates where fruit is particularly subject to this type of blemishing, picking in the rain should be avoided and in general in wet weather should not be undertaken until 10.00 a.m.

3. Considerable differences in the amounts of fungal wastage in fruit from different estates have been demonstrated.

4. The very satisfactory control of wastage that attends expeditious handling and rapid cooling to 45°F. has again been demonstrated.

5. Wet season fruit which has to be coloured by treatment with ethylene is previously given a borax dip. It has been shown that whereas the ethylene treatment gives some control of fungal wastage (*Botryodiplodia theobromae*) due to the "debuttoning" which it induces, the borax treatment, as indicated in a previous report, considerably increases fungal wastage by causing a premature development of latent infections of *Colletotrichum gloeosporioides*. *As the pathogens which the borax treatment is intended to control are of very minor importance in Trinidad grapefruit, this treatment should be discontinued even in fruit which has to be coloured with ethylene.*

6. Data are given on the rates of cooling and incidence of chilling in crated and uncrated fruit exposed to air at 40° and 45°F. For wet season fruit it has been shown that the chilling temperature lies very close to 45°F.—the temperature at present used for storage. If air is delivered at 40°F. in order to obtain rapid cooling this must not be continued beyond the first 12-15 hours. In other words, a Trinidad citrus pre-cooling plant should have refrigerating capacity to permit of rapid air circulation to storage rooms at 40°F., and provision for raising this temperature to 45°F.

The writers wish to express their thanks to the Co-operative Citrus Growers' Association and to members of the planting community for their assistance in providing supplies of fruit.

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RAT CONTROL.*

Of the common rat poisons investigated—thallous sulphate, yellow phosphorus, the alkaloid strychnine, strychnine hydrochloride, strychnine sulphate, zinc phosphide, red squills, white arsenic (As_2O_3) and barium carbonate—it is considered that all but the first three can be discarded as unsuitable for Queensland cane field conditions.

The foods which have been used for bait bases can be listed in order of preference by the rats as follows—rolled oats, cracked corn, whole corn, wheat meal, whole wheat, barley and bread. Rolled oats stand out above the others; there is very little difference between the next four; barley is not a food particularly desired by the field rat; and there is always a very poor intake of bread.

It has been found that thallous sulphate and the alkaloid strychnine should not be used on bread, but it would be uneconomic and unnecessary to use phosphorus on a base other than bread unless an even cheaper bait base were available. The intake of thallous-sulphate-treated grain decreases with bait strength. It is considered that under present methods of distributing thallous-sulphate-treated grain in Queensland cane fields—*i.e.* in packet form—a bait strength approximating to 1 : 300 would be most economical.

The unsoundness of using "take" as a criterion for comparing the effectiveness of different poisons, baits or bait strengths in the field has become evident. Thallous-sulphate-treated wheat (1 : 500) usually exhibits a comparatively large intake per rat, while phosphorus, on bread, is not particularly attractive to the pests. Nevertheless, it has been found that, in reducing field populations, an obviously poor take of the cheap phosphorus bait, with its extremely high toxicity, has about the same effect as an excellent take of the less toxic thallous-sulphate-treated wheat. It would appear that the addition of linseed oil to poison bait is unnecessary.—(*Int. Sugar Jr.*, Vol. XLI, No. 486, p. 236, 1939.)

* By A. F. Bell. *See* also *I.S.J.*, 1939, p. 94.

IMPROVEMENT OF DAIRY CATTLE IN THE TROPICS.

A. D. Buchanan Smith in a section of an article on the Genetics of Dairy Cattle* reviews the position in the tropics as follows: Wright (1) has a comprehensive report on the question of the improvement of dairy cattle in India. No substantial improvement in the way of breeding is possible until the cattle can be better fed and until there is adequate control of disease. The question is discussed of the issue of bulls by the Government as a means for improving the quality of the stock throughout the country. The writer advocates that this policy should be pursued with greater diligence, as also the castration of inferior males. The average yield of milk of the Indian dairy cow is only slightly over 600 lb. per year, representing a daily yield of about half a gallon. Crossing with European breeds has been successful when restricted to the first cross, particularly at the Military Dairy Farms, but further breeding with imported blood is not particularly promising. Back-crossing to native cattle improves constitution, but reduces yield. Deterioration in the constitution of adult stock appears to be due not so much to cross-breeding as to the effect of high yield under the rigorous climatic conditions of India; there are indications of increased susceptibility to disease and loss of constitution, even among Indian dairy cattle, when their milking performances improve. A report on the Government Sahiwal herd at Pusa, which covers a period from 1913 to 1937 has been published (2). The figures contained are interesting. The Imperial Council of Agricultural Research have recently (3) published an illustrated survey of some of the important breeds of cattle in India, with excellent illustrations. Representative milk yields are given. To this Olver contributes a critical survey of the origins of Indian cattle, which he roughly classifies into five basic types; he describes representatives of the principal breeds of each type. Reporting that systematic investigation carried out by the Animal Husbandry Bureau of the Imperial Council of Agricultural Research in India has shown that, by careful selection and proper feeding and management, herds of pure Indian cattle have been produced in 25 years, Olver (4) states that they can more than hold their own in India with European cattle and the best Indian buffaloes. Some of these herds already exceed the milk yield of commercial herds in Europe and America: he states that even with the best of care, cattle of European origin tend to degenerate in India. In this paper he describes how the improvement of dairy cattle in India should proceed and states that more milk should be bred into the Indian breeds of work cattle.

Watson (5) describes the acclimatization of Ayrshire, Jersey and Holstein cattle in Hong Kong. Permanent sterility is more common in imported animals than in those bred locally. Stuchbery (6) describes herd testing in Fiji. The breeding efficiency of grade Ayrshire cows in the Philippines was found by Fernandez (7) to be about 67 per cent. but varies according to conditions: Sussex × Nellore cows averaged 50.6 per cent. Williams (8) reports observations for 14 years on a pure bred Holstein-Friesian herd maintained in a sub-tropical part of the U.S.A. Specially noted are sexual weakness in bulls, as well as cows, fertility being conditioned by the weather: when breeding efficiency was high, the sex ratio was low, and *vice versa*.

Kothavala and Sunawala (9) studied the number, size and shape of the fat globules in seven dairy and four draft breeds of Indian cattle, as well as three breeds of buffalo. In the milk of the buffalo the fat globules were large and the number low as compared to cow's milk. Fat globules are more numerous and more uniform in the milk of the draft than in the dairy breeds.

Other references to dairy cattle problems in the tropics are to be found in the reports of Government departments concerned. Particular reference might, however, be made to Bihar and Orissa (10), the *Annual Report* of the Imperial Dairy Expert in India (11), Jamaica (12) (where the milk production averages by breeds and lactation periods are given), and Palestine (13) (where the Brown Swiss has acclimatized well).

More attention requires to be given to the subject of the water buffalo. In addition to the paper by Kothavala and Sunawala (9), mentioned above, is a book by Pissarewsky (14): it describes the distribution of these animals in different parts of the world, their management, the conformation, signs of milk, &c.: figures are given on breed differences in yield and how it is affected by age, season, nutrition and management. Further information on this subject is to be found in the Madras Report (15) and in that of Olver (4).

* Genetics of Dairy Cattle, *Journal of Dairy Research*, X, 2, 1939.

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MACHINERY FOR PREPARATION OF TUNG OIL.

In a note on the preparation of Tung oil published in the *Bulletin of the Imperial Institute*, 1938, Vol. XXXVI, 357-360, a description was given on methods employed for decorticating Tung fruits and seeds and for expressing the oil. The methods generally entailed the use of decorticating and expelling machinery. Growers of Tung seed who may be contemplating mechanical decortication of their fruit or erecting crushing plant will be interested to know that suitable machinery for both purposes is manufactured in the United Kingdom. The firms concerned have given demonstrations of their plant before representatives of the Imperial Institute Sub-Committee on Tung Oil and the results indicated that the machines in question should prove quite satisfactory. Several decorticators of varying capacity are offered, namely, 12 in. hand-power model, dealing with 100-120 lb. of fruit per hour; 15 in. power-driven model with a capacity of 500-600 lb. of fruit per hour; 15 in. power-driven combined decorticator and separator of the same capacity; and 24 in. power-driven combined decorticator and separator capable of treating 14-15 cwts. of fruit per hour. The most suitable and economical expeller can deal with 5 cwts. of decorticated seed per hour and is designed to work in conjunction with the 24 in. combined decorticator and separator. For further particulars of these machines, their prices and the names of the makers, application should be addressed to the Director of the Imperial Institute.—(*Bull. of the Imperial Institute*, Vol. XXXVII, No. 2, 1939, p. 199.)

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SUGAR NOTES.

(*Compiled by the College Department of Sugar Technology.*)

Mechanical Harvesting in Hawaii.

The last two annual reports of the Committee on Labour Saving Devices of the Hawaiian Sugar Planters' Association have contained interesting references to new methods of mechanical harvesting by means of grabs and rakes (1), as well as by harvesting machines proper, such as the Falkiner. Further particulars of these methods are to be gleaned from a paper by W. J. Maze, read at the Sixth Congress of the International Society of Sugar Cane Technologists, held at Baton Rouge last autumn, and now available in the published Proceedings (2).

The idea of mechanically cutting and loading cane in the fields in Hawaii has made its greatest advance through the development of grab harvesting, whereby the cane is dragged off from the roots and lifted direct into transport vehicles. The cane grab is not a new idea, having been in use in Louisiana for over 30 years; but in the latter country the grabs are all small, picking up about 500 lb. of cane, whereas in Hawaii development has been along the lines of large grabs worked by crawler or track-laying type cranes, handling much larger amounts.

The latest grabs are of tubular construction weighing about 1,600 lbs. each, and having a spread of 12 ft., a width of usually 7 ft., and are about 5 ft. high to the hinge pin. They pick up from 1½ to 2 tons of cane at a time. The travelling cranes have a boom 40 ft. long and usually operate on about a 35 ft. boom radius.

It was soon found that cane could be successfully harvested with these grabs, owing to the fact that the cane easily breaks off at the point where the stalk joins the roots. But it should be borne in mind that most Hawaiian cane is from 18 to 24 months old when harvested and by that time there is a heavy mat of cane on the ground which can be torn loose from its roots by a grab and deposited on to the transport vehicles. In operation the grab is lowered in the open position over a mat of cane; it closes and raises in one operation. The grab is immediately lowered again and the cane in the grab is deposited on unharvested cane. These operations are repeated till the grab has a full load of cane, when the load is then swung round and dropped into the waiting vehicles. This solves the not unimportant problem of how expeditiously to deal with the cut cane with a minimum of loading labour.

A variation from this method of grab harvesting has more recently been developed on the estate of the Waialua Agricultural Co., and is termed drag line harvesting. Like the former, it breaks the cane off from the roots. Here a crawler crane and a tractor fitted with a winch are used. A

(1) *See I.S.J.*, 1938, pp. 258-260; 1939, pp. 179-181.
(2) Page 524.

large drag line rake is hauled into the cane, as a rule a distance of about 75 feet, by the crane. The tractor is used for the back hauling with the rake of cane. By this method the cane is raked into heap rows, whence a crane fitted with a grab picks it up and loads it on to the transport vehicles (1).

The principal drawback to these methods of harvesting is that they ordinarily entail cleaning the cane of trash, rocks and dirt, either in the field or at the factory, before it can be successfully milled. But on some plantations which harvest during dry weather, the cane can be burnt clean of trash and tops in advance, and very little dirt is picked up by the grabs. Under these conditions, grab-harvesting cane may give comparatively little trouble from anything except rocks and tramp iron. Under less favourable conditions cane-cleaning plants or rock and mud separators have to be installed at the factory.

In the Discussion which followed the reading of Mr. Maze's paper, the following further facts were elicited. The grab harvesting method works best when handling heavy cane crops of 80 to 120 tons cane per acre, but it has been used with lighter fields, even in 50-ton cane; but much must depend on the variety and soil. With a cane that snaps off and a soil that holds, the grab works all right. In a soft soil an appreciable amount of re-planting may be necessary, while it is very difficult to harvest a field with heavy sucker growth, as the suckers will not readily break off.

As compared with hand harvesting, while there is a loss in recovery at the mill, the two methods should give about the same returns on a per acre basis. With hand harvesting there is always a certain loss from the inch or two of stalk left at the bottom; the grab harvester breaks the sticks off a little below the soil. Hence the grab gives a slight increase of cane per acre taken into the mill.

The cane is burnt before harvest and with a good burn the trash content should be reduced to about 15 per cent. instead of 30 per cent. or higher. Steps are being taken to separate trash from the cane in the fields, but no definite method has been worked out as yet.

Reference was also made to the Falkiner harvester. The cost of harvesting with this machine and delivering to the mill is reported to be less than the hand system but not necessarily less than the grab method. It works better in wet cane. Its use is limited to level land and on many plantations would not be successful. The grab system, on the other hand, can be operated on sloping land. The cost of hand harvesting in Hawaii is based on a wage which in 1937 averaged $2.37 for an 8-hour day, the average cutting per man per day being about 10 tons.—(*The International Sugar Journal*, Vol. XLI, No. 487, July, 1939, pp. 272-273.)

(1) *See I.S.J.*, 1939, p. 181, for an illustration of this rake.

Conversion of Cane Molasses into Manure.—*By H. D. Sen.*

Information regarding the production of a concentrated manure by means of a fermentation process has already been published*, and some of the results obtained with it are now reported. Working with the three cane varieties—Co.313, Co.312 and Co.331—early, medium and late ripening varieties—with six replications in randomized blocks, indicated that molasses, when directly applied in the soil had a definitely depressant effect as compared with the control in heavy doses, which increase with increased application, although in smaller doses the effect was not very significant. On the other hand, the concentrated manures gave definitely increased cane yields, comparable with those obtained by using castor cake as manure. The sucrose per cent. in cane was significantly higher than with molasses alone. Taking a particular variety the yield of cane was 100 maunds more per acre with the prepared manures as compared with control, while direct molasses application gave 100 maunds of cane less. There was an increase of 20 maunds of sugar per acre with the new manures over the control, while there was a decrease in the yield of 20 maunds of sugar in the case of direct molasses application—(*Int. Sugar Jr.*, Vol. XLI, No. 486, p. 233, 1939.)

* *Int. Sugar Jr.*, 1939, p. 152.

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Separation of Molasses from the Sugar Crystals in Centrifugals. *E. R. Behne.* Technical Communications No. 8 (1938); Bureau of Sugar Experiment Stations, Brisbane.

This is a theoretical treatment of the rate of elimination of molasses from the sugar in the centrifugals, the process being considered in three steps: (*a*) the elimination of the molasses in excess of the void volume, (*b*) the partial emptying of the voids, and (*c*) the drainage of the molasses adhering to the surfaces of the crystals. A final formula was developed, based partly on the theoretical reasoning and partly on experimental results. The influence of evaporation of the molasses film adhering to the crystals was demonstrated and was found to be greater with increasing temperature. This factor has been suggested as magnifying the essential difference between dilution and re-heating as pre-treatment methods. The necessity is stressed for eliminating the occurrence of evaporation by the simple procedure of closing the fugals and using a small amount of exhaust steam inside the fugal basket.—(*The International Sugar Journal*, Vol. XLI, No. 487, July, 1939, p. 283.)

SPRAYING MACHINERY.

We have recently been informed by Messrs. Cooper, Pegler & Co., Ltd., 29 & 31, Clifton Street, Finsbury Square, London, E.C.2 that they will gladly supply their newest catalogue showing a complete range of their latest spraying and dusting machinery to interested readers on request.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Extraction of Saponin from Soap Nut.—*By J. L. Sarin and M. L. Beri.*

An efficient and commercially practicable method has recently been worked out at the Government Industrial Research Laboratory, Lahore, for the extraction of saponin from soap nut, a raw material which is found abundantly in India. The extraction of saponin from this source had not hitherto been possible on a commercial scale.

The soap nut selected for extraction was from the *Sapindus mukorossi* species and consisted of 56.2 per cent. pericarp and 43.8 per cent. seed. The pericarp, in which the saponin occurs, was sun-dried, powdered and extracted with ethyl acetate. The extract, on distillation, yielded crude saponin which was purified by dissolving in water and adding a solution of barium hydroxide. The precipitated barium salt of saponin was suspended in dilute alcohol and decomposed by carbon dioxide into barium carbonate and saponin. The saponin solution was evaporated and the resulting saponin recrystallised from ethyl alcohol. The yield was 30.31 per cent. on the weight of the pericarp and 17.17 per cent. on the weight of the soap nut. This yield is higher than has been obtained from any other known saponin-yielding plant.

The soap nut saponin prepared could be utilized for the same purposes as saponin from other sources, *e.g.* as an emulsifying agent for vegetable and essential oils, as a foam stabilizer, in the manufacture of soapless shampoos and to increase the spreading power of sprays upon foliage.—(*Industrial and Engineering Chemistry*, Vol. XXXI, No. 6, p. 712, 1939.)

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Methyl Alcohol Content of Tobacco Leaf and Ribs.

Numerous workers have shown that tobacco smoke contains methyl alcohol derived mainly from methyl pectic esters. The methyl alcohol yield from unfermented tobaccos may reach 0.9 per cent., but during fermentation the yield is considerably reduced so that, as a rule, pale tobaccos yield more alcohol than dark tobaccos. When the coarser parts of the leaf (midrib and large veins) are used there is an increased yield of methyl alcohol derived from the lignin constituents of the woody tissue.

W. Preiss (*Z. Unters. Lebensm.*, 1939, LXXVII, 272-281*) recently determined the pectin methyl alcohol and lignin methyl alcohol contents of various portions of different species of tobacco. He found that the methyl alcohol derived from pectin bodies is very small in the large-leaved tobaccos of the alkaline group and that tobacco ribs yield less pectin methyl alcohol than the whole or stripped leaf. In oriental cigarette tobaccos of the acid group the pectin methyl alcohol content is higher than in the alkaline group and amounts to about 0.5 per cent. Methyl alcohol derived from lignin amounts to about 0.2 per cent. in the large-leaved tobaccos, 0.4 per cent. and more in the ribs and 0.12 per cent. in the stripped leaves. Oriental tobaccos yield about 0.1 per cent. of methyl alcohol from lignin. The amount of lignin methyl alcohol obtained is a measure of the lignified tissue in the tobacco product and may be used to determine approximately the amount of rib and vein present. The methods described by the author for the determination of pectin and lignin methyl alcohol provide a useful means of following the effects of the processes of tobacco manufacture upon its pectin and lignin contents.

*See also *Analyst*, Vol. LXIV, 759, p. 437 (June, 1939).

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Earthquakes and Atmospheric Pressure.

The effects of changes of atmospheric pressure on the occurrence of about two hundred New Zealand earthquakes from 1931 until 1936 are examined by Mr. R. C. Hayes in a brief but interesting paper (*Wellington Dom. Obs. Bull.*, No. 124; 1937). When the pressure rose or fell by one-tenth of an inch or more within one or two days before an earthquake, a positive or negative sign was entered at the position of the epicentre. In general, it was found that earthquakes with centres on land were associated with a rise of pressure, and those with centres at sea with a fall, the different signs predominating in series of zones running north-east and south-west, parallel to the main folds and fault-systems of the islands. The most extensive zone is one marked by negative signs lying off the east coast of the North Island, and this is bounded to the north-west by an almost equally well-defined zone on land with positive signs.—(*Nature*, Vol. CLXI, No. 3560, p. 167.)

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Tamarinds and Molasses as Source of Cream of Tartar.

The Biochemistry Department of the Indian Institute of Science has patented a process for the recovery of potash from molasses in the form of Cream of Tartar. A rich extract of the Tamarind fruit is the source of the tartaric acid, which is added in equivalent amount to the molasses at a dilution of 1 to 2. The precipitation is as complete as with pure acid.—(*Ind. & Eng. Chemistry*, News Edition, Vol. 17, No. 4, p. 138, 1939.)

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Alcohol from Potatoes.

The Potato Marketing Board of British Guiana, has worked out plans for eight factories situated in different parts of the country to produce ethyl alcohol from potatoes. It is also considering the erection of factories for the manufacture of ether, ethyl chloride, ethyl acetate, acetic acid, acetone, acet-aldehyde, acetic anhydride, butyl alcohol, and ethyl glycol.—(*Ind. & Eng. Chem., News Edit.*, Vol. 16, No. 19, p. 528.)

TREND OF THE MARKETS.

[The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices are spot, London.]

SUGAR.—Prices on the Home Market have ranged as follows (*c.i.f.* per cwt.) :—

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
29th June	8	3	12	0
6th July	8	1½	11	9
13th July	7	6	11	6
20th July	7	1½	11	0
27th July	7	1½	10	9
3rd August	6	10½	10	3
10th August	6	11	10	4½
(*11th August*, 1938)	5	3¾	9	1½

During the period under review the raw sugar market has been very irregular, prices fluctuating from 7*s.* 6*d.* up to 8*s.* 3*d.* down to 7*s.* 1½*d.* On the 14th July the British Government's request for a further release of 100,000 tons was granted and caused a shrinkage in prices. In view of the uncertainty as to the precise tonnage which will be made available for the United Kingdom's requirements as a result of this release, marketing conditions have been rather difficult and values are of a more or less nominal character, being determined strictly according to date of arrival.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	Pence per lb.
28th June	8 1-4
5th July	8 3-16
12th July	8 1-4
19th July	8 3-8
26th July	8 5-16
2nd August	8 1-2
9th August	8 9-16
(*10th August*, 1938)	7 3-16

On 25th July the International Regulation Committee decided to fix the exportable percentage at 60 per cent. of the basic quotas for the last quarter of the year and also to revise the quota for the current quarter from 55 to 60 per cent. The main reason probably for this decision was the undesirability of allowing stocks to fall further in the current quarter. Although business has not been very active prices have been steady. The American consumption for June, 1939, at 47,259 tons is larger than had been expected.

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LIME PRODUCTS.—*Lime Oil.* Handpressed remains scarce and the prices are still unchanged at 27*s.* 6*d.* to 30*s.* per lb. according to quality. Distilled is now quoted at 11*s.* 6*d.* to 12*s.* per lb. according to quality.

Lime Juice. There is still no demand for concentrated. Raw remains quiet and unchanged, at 1*s.* 9*d.* to 2*s.* 3*d.* according to quality.—(*West India Committee Circular*, 27th July, 1939.)

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American	*Egyptian*	*F.G.F.*
	Mid.	*Giza 7.*	*Sakel.*
30th June	5.62	6.56	6.46
7th July	5.61	6.68	5.99
14th July	5.52	6.51	5.91
21st July	5.23	6.35	5.73
28th July	5.40	6.49	5.83
4th August	5.28	—	—
11th August	5.22	—	—
(*12th August*, 1938)	4.78	7.36	7.71

The outstanding event on the raw cotton market has been the announcement of the American export subsidy which came into force on 27th July. This has been fixed at 1½ cents per lb. on raw cotton and 1.80 cents to 2.10 cents per lb. on manufactured goods. According to Mr. Wallace the system will only be temporary and may be removed through an international agreement. The decision has had little effect on the market, and it is expected that in the immediate future raw cotton prices will depend a good deal on reports concerning the prospects for the new crop. The weather in the American cotton belt has been generally favourable and it is expected that the area planted will yield between 11 and 12 million bales. Business in West Indian Sea Island Cotton continues limited.

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COCOA.—There is practically no change to report in the cocoa market since last writing. New developments, however, generally present themselves when least expected, therefore one should not overlook the possibility of a sudden upward price trend in the event of another crisis in the European political situation, unfavourable crop reports or a possible repetition of a farmers' strike in the Gold Coast. New crop Accra is quoted at 20*s.* 6*d.* and locally $7.60 per fanega is paid for Plantation Cocoa.—(*By courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

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COPRA.—The value of f.m.s. has again dropped to £10.

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COFFEE.—Fine qualities *Jamaica* sold from 192*s.* to 210*s.* per cwt. for bold sizes. *Brazil*: Superior, 29*s.* per cwt. *c.i.f.* and *Rio No.* 7 slightly easier at 21*s.* 3*d.* *Kenya*: A size sold from 58*s.* 6*d.* to 69*s.* per cwt.

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BANANAS.—Market conditions have generally been fair to quiet. Jamaicas are unchanged at £20 15*s.* delivered London and £20 10*s.* delivered station provinces.